MULTIMEDIA UNIVERSITY

STUDENT ID NO

MULTIMEDIA UNIVERSITY

SUPPLEMENTARY EXAMINATION

TRIMESTER 1, 2015/2016

ETN3046 – ANALOG AND DIGITAL COMMUNICATIONS

(CE, EE, LE, ME, NANO & OPE)

18 NOV 2015
9.00 AM – 11.00 AM
(2 HOURS)

INSTRUCTIONS TO STUDENTS

1. This Question paper consists of 6 pages (including the cover page) with 4 Questions only.

2. Attempt all of the **FOUR** questions. All questions carry equal marks and the distribution of the marks for each question is given.

3. Please write all your answers in the Answer Booklet provided.

Question 1

(a) State two main concerns in the design of communication systems.

[3 marks]

(b) Give one example of analog sources and one example of digital sources.

[2 marks]

(c) Discuss briefly the requirements to achieve distortionless transmission.

[3 marks]

(d) Sketch the single-sided and double sided magnitude spectral plots for the signal $x(t) = 20 + 10\sin(20\pi t) + 20\cos(20\pi t)$.

[10 marks]

(e) Evaluate the Fourier transform of the signal $y(t)$ shown in Figure Q1.1.

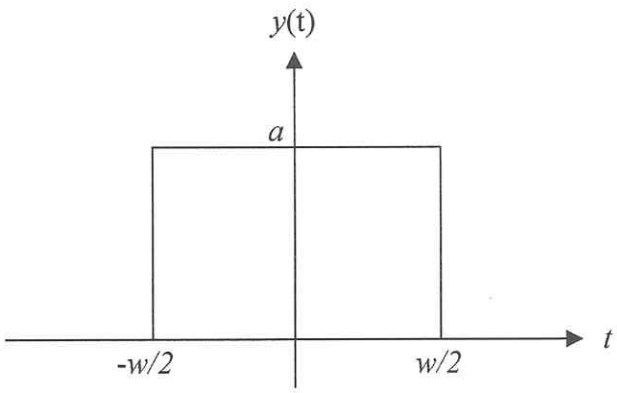

Figure Q1.1: Signal $y(t)$.

[7 marks]

Question 2

(a) An antenna transmits a double sideband large carrier (DSB-LC) modulated signal having a total power content of 20 kW. The percentage of modulation is 75%. Compute the following:

(i) Power transmitted at the carrier frequency.

[3 marks]

(ii) Power transmitted at each of the sidebands.

[3 marks]

(iii) Power efficiency.

[3 marks]

Continued .....

Question 2

(b) A message signal $m(t)$ has a spectrum $M(f)$ as shown in Figure Q2.1 This signal is used to modulate a carrier signal $s_c(t) = A_c \cos(2\pi f_c t)$ using the single sideband (SSB) modulation scheme. Assume that $f_c > f_a + w$.

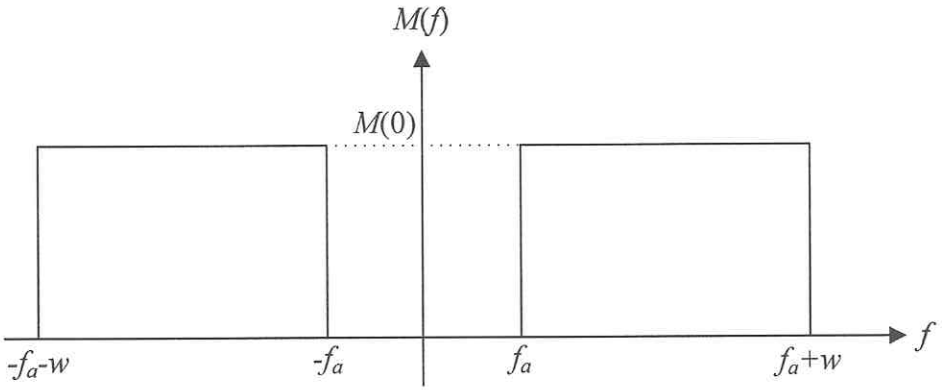

Figure Q2.1: Spectrum of message signal $m(t)$.

(i) Sketch the single sided magnitude spectrum of the modulated signal if the upper sideband (USB) is transmitted using the SSB modulation scheme. [2.5 marks]

(ii) Sketch the single sided magnitude spectrum of the modulated signal if the lower sideband (LSB) is transmitted using the SSB modulation scheme. [2.5 marks]

(iii) Determine the minimum bandwidth required to transmit the modulated signal. [1 mark]

(iv) Discuss the main drawback of the SSB modulation scheme. [3 marks]

(c) With the aid of diagrams, explain the functions of pre-emphasis and de-emphasis used in frequency modulation (FM) system. [7 marks]

Question 3

(a) Answer the following:

(i) Define the term PAM. [2 marks]

(ii) With the aid of a suitable diagram, explain the principle of operation of the natural sampling process. [4 marks]

Continued .....

Question 3

(b) A modulating wave of frequency 5 MHz in Figure Q3.1 is applied to the input of a PCM system. The system samples the signal at a rate 75% above the Nyquist rate, and uses a uniform quantizer of the midrise type with L quantization levels followed by an R-bit binary encoder.

(i) Determine the sampling rate. [2 marks]

(ii) If the signal-to-quantization noise ratio is required to be at least 50 dB, estimate the minimum value of L. [6 marks]

(iii) Based on Part (b)(ii), a single-error correcting linear block code with a code efficiency of 0.77 is considered. Find the number of binary digits required to encode each sample and the bit rate of the binary coded signal. [3 marks]

(iv) Following Part (b)(iii), the binary data is transmitted using 8-ary phase-shift keying (8-PSK). Calculate the minimum transmission bandwidth to transmit this data with zero intersymbol interference (ISI). [4 marks]

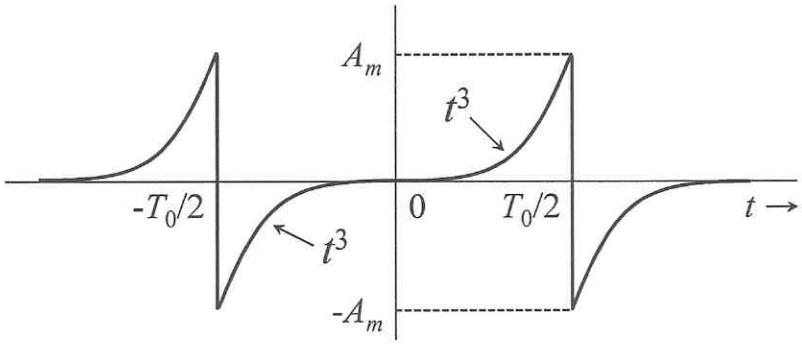

Figure Q3.1

(c) Sketch the waveforms for the binary sequence '**0 1 1 0 1 0 1 0**' using the following signaling formats:

(i) Bipolar return-to-zero (RZ) [2 marks]

(ii) Manchester nonreturn-to-zero (NRZ) [2 marks]

Continued .....

Question 4

(a) Explain the construction of the eye diagram.

[3 marks]

(b) A zero-memory source emits two messages m_1 and m_2 with probabilities of occurrence 0.7 and 0.3, respectively. A third-order extension of this source generates eight possible messages as follows:

Messages
$m_1m_1m_1$
$m_1m_1m_2$
$m_1m_2m_1$
$m_2m_1m_1$
$m_1m_2m_2$
$m_2m_1m_2$
$m_2m_2m_1$
$m_2m_2m_2$

(i) Find the entropy of the source.

[6 marks]

(ii) Compute the Shannon-Fano code for these messages.

[8 marks]

(iii) Determine the efficiency of the Shannon-Fano code.

[3 marks]

(c) Consider a (6, 3) Hamming code generated by the matrix:

$$G = \begin{bmatrix} 1 & 0 & 0 & 1 & 1 & 1 \\ 0 & 1 & 0 & 1 & 1 & 0 \\ 0 & 0 & 1 & 1 & 0 & 1 \end{bmatrix}$$

Compute the syndrome for the received codewords: **101100**, **000110**, and **101010**. Justify if any of these codewords are erroneous, and find the correct codeword.

[5 marks]

Continued .....

Appendix 1: Table of Fourier Transform Properties

Let $x(t) \Leftrightarrow X(f)$, $x_1(t) \Leftrightarrow X_1(f)$ and $x_2(t) \Leftrightarrow X_2(f)$; and a, b, t_o and f_o scalar quantities.	
Linearity	$ax_1(t)+bx_2(t) \Leftrightarrow aX_1(f)+bX_2(f)$
Scaling ($a \neq 0$)	$x(at) \Leftrightarrow \frac{1}{\lvert a \rvert} X\left(\frac{f}{a}\right)$
Time Shifting	$x(t-t_o) \Leftrightarrow X(f)e^{-j2\pi ft_o}$
Frequency Shifting	$x(t)e^{j2\pi f_o t} \Leftrightarrow X(f-f_o)$
Time Convolution	$x_1(t) * x_2(t) \Leftrightarrow X_1(f)X_2(f)$
Frequency Convolution	$x_1(t)x_2(t) \Leftrightarrow X_1(f) * X_2(f)$
Time Differentiation	$\frac{d^n}{dt^n}x(t) \Leftrightarrow (j2\pi f)^n X(f)$
Frequency Differentiation	$(-jt)^n x(t) \Leftrightarrow \frac{d^n}{df^n}X(f)$
Time Integration	$\int_{-\infty}^{t} x(\tilde{t})d\tilde{t} \Leftrightarrow \frac{X(f)}{j2\pi f}+\frac{1}{2}X(0)\delta(f)$
Frequency Integration	$x(t)u(t) \Leftrightarrow \int_{-\infty}^{f} X(\tilde{f})d\tilde{f}$

End of Paper